science in this fertile land. We applaud the author on his achievement; others may express this appreciation more analytically; but in this paragraph we acclaim the high-minded attitude of the Geological Society of America in making so wise a use of its money and so excellent a contribution to the common good of the Pan-American States and to geological science.

J. M. C.

WEIGHT OF BODY MOVING ALONG EQUATOR

TO THE EDITOR OF SCIENCE: A prominent engineer, Dr. Carl Herring, recently proposed to me the following question: "Does a body in motion along the earth's equator weigh less (or more) than the same body at rest?" Since this question, in some form or other, has come up several times in recent discussions, the following solution, although entirely elementary, may be not without interest.

Let us picture the body as supported by a string from the roof of a train running westward at speed v along the equator, and let $S =$ the tension in the string.

The question then is: What is the relation between S and v?

Let V ($= 1{,}038$ miles per hour) be the absolute velocity of a point on the earth's equator (neglecting the motion of the earth in its orbit and the motion of the solar system in space). Then $V\text{-}v$ is the absolute velocity of the train (eastward) in a circular path of radius R ($= 3{,}963$ miles).

Hence, by a well-known formula of kinematics, $(V\text{-}v)^2/R =$ the absolute acceleration of the body toward the center of the earth.[1]

Further, let $W =$ the ordinary weight of the body (that is, the value of the supporting force S when the train is at rest on the earth's surface), and $g =$ the ordinary falling acceleration (that is, the acceleration, with respect to the earth's surface, with which the body would begin to fall, from rest, if the supporting string were cut); and let $E =$ the force with which the earth pulls the body toward the center of the earth. Then $E\text{-}S =$ the net force acting on the body in the direction toward the center.

Hence, by the fundamental principle that forces are proportional to the accelerations they produce,[2] we have

$$\frac{E - S}{W} = \frac{(V - v)^2/R}{g}, \tag{1}$$

whence

$$S = E - \frac{W}{g}\,\frac{(V - v)^2}{R}. \tag{2}$$

To determine E, we note that if $v = 0$ then $S = W$, so that

$$E = W + \frac{WV^2}{gR} = (1.00345)W. \tag{3}$$

Hence finally,

$$S = W\left\{1 + \frac{V^2}{gR}\left[1 - \left(1 - \frac{v}{V}\right)^2\right]\right\}. \tag{4}$$

From these equations we see that as v, the westward train-speed, increases from 0 to V, the supporting force S will increase from W to (1.00345) W, which is its maximum value; as v increases from V to $2V$, S will decrease again from its maximum value to W; and if v is increased further to about 18 V, S will become zero.

For reasonable train-speeds, therefore (up to one or two thousand miles per hour!), *a body moving westward will require an increased force to support it against falling.*

For example, let $v = 60$ miles per hour. Then if $W = 1$ lb., we find $S = 1.000387$ lb., an increase of about 1/25 of one per cent.

[1] Dr. Hering's surprising statement in SCIENCE for October 24, 1919, implying that engineers do not generally recognize the idea of "acceleration" in a direction perpendicular to the path, is not borne out by an examination of engineering text-books, all of which (fortunately) define acceleration in the standard way as the rate of change of vector velocity. For further comment on Dr. Hering's paper, see Professor C. M. Sparrow's letter in SCIENCE for November 21.

[2] Reasons for preferring the form $F/F' = a/a'$ to the form $F = ma$ as the fundamental equation of mechanics may be found in two articles by E. V. Huntington: "The Logical Skeleton of Elementary Dynamics," *American Mathematical Monthly*, Vol. 24 (1917), pp. 1–16; "Bibliographical Note on the Use of the Word Mass in Current Text-Books," *ibid.*, Vol. 25 (1918), pp. 1–15; also in controversial papers in SCIENCE from December, 1914, to October, 1917.

Of course if the train runs *eastward*, the required supporting force will be *less* than if the train were at rest. In particular, if the eastward train-speed is about 16 V, S will be zero.

There are thus two speeds, one westward of about 18,700 miles per hour, and one eastward of about 16,700 miles per hour, at which the "weight" of the body as measured by an observer on the train (that is, the tension in the supporting string S) would be zero.

EDWARD V. HUNTINGTON

HARVARD UNIVERSITY,
November 22, 1919

AN ODD PROBLEM IN MECHANICS

TO THE EDITOR OF SCIENCE: In a recent discussion the writer offered the following problem which seems to be new and of interest, judging from the answers and lack of answers.

Assuming the earth to be a perfect sphere, the net weight of a body on this earth is G—C, in which G is the force due to gravity and C the centrifugal force due to the rotation of the earth. Hence the net weight of a body at the equator when moving east at a velocity (relatively to the earth) equal to that of the surface of the earth, about 1,000 miles per hour would be G—4C, that is, less than when at rest, while when moving west at the same velocity it would be G, that is, greater than when at rest.

If therefore a flywheel were revolved at the equator with that circumferential speed and in a horizontal plane, the northern part moving east, it would seem to follow that it will tilt to the south, as the southern half should be heavier than the northern half. Due to a time lag the tilting might be to the southwest. It is here assumed that its gyroscopic tendency to get into a vertical plane has been duly counteracted and may be neglected.

Or stated in a different form, suppose a light disc be revolved at this speed in a vertical plane at the equator, and to have two equal symmetrically placed, heavy masses on its rim. When the plane of rotation is north and south it would be dynamically balanced, but when that plane is east and west it would seem to follow that the masses at the moment they are at the bottom would be heavier than when at the top and if so the disk would be unbalanced dynamically, vibrating with a period double that of the period of revolution. Its center of gravity would oscillate below its center of rotation.

It is acknowledged to be possible, theoretically at least, to move a mass so rapidly over the earth that G = C hence the net weight then is zero; it would then go on encircling the earth, if the air friction were eliminated; the moon is an illustration. At lower speeds therefore there should be a part of this loss in effective weight.

The two cases cited, if the results are as described, would afford a basis, theoretically at least, for a mechanical compass, like the gyroscope compass.

CARL HERING

PHILADELPHIA,
October 27, 1919

QUOTATIONS

SCIENCE AND THE NEW ERA PRINTING COMPANY

Old wood to burn,
Old books to read,
Old wine to drink,
Old friends to cling to.

IT takes a near-millionaire to burn "old wood" on his hearth these days; "old books" are the delight of the bibliophile, but are poor stuff in producing the wherewithal of a printing establishment; "old wine" will soon be only a hollow mockery—

But "old friends to cling to!" Ah! there is the kernel, the gem that glitters from the quadruplet!

All of which is just by way of introduction to an acknowledgment of one of the most gracious compliments ever paid to The New Era Printing Company.

As the year fast nears its close, it marks the twenty-fifth anniversary of The New Era Printing Company's production of SCIENCE, a magazine whose contributors embrace the